NBS

Status Report

NASA Contract R-126/06-06-013

Ionospheric Electron Density Studies and Computations

December 1, 1965 - March 31, 1966

Introduction

NASA Contract R-126/06-06-013 provides for research and data analysis in the application of ground-based radio ionospheric measurements to NASA programs in aeronomy. Emphasis is placed in four primary areas: (1) Research concerning methods of radio ionospheric measurement and data analysis having direct pertinence to the needs of particular rocket/satellite programs in aeronomy. (2) Data analysis and consultation in applications of ground-based radio ionospheric measurements for NASA and NASA-supported rocket-probe and satellite programs in aeronomy. (3) Development of a reliable and complete climatology describing the structure and variations of the ionosphere, so that individual rocket and satellite experimental results may be placed in the context of geographic diurnal, seasonal, and solar-cycle variations of the atmosphere. (4) A small research effort to use the data and facilities of the program in studies of E and F region physical processes. This report summarizes our activities in these categories during the period ending March 31, 1966.

1) Development of Analysis Methods:

Conversion of the main analysis program to the new computing facilities is completed and is available to other users in a generally-useful computer language. The program includes the option of one of four "starting" calculations for the F-region, described in detail in the status report for July 1 - November 30, 1965. Most recent changes have been of a "housekeeping" nature, and include such things as improvement of data formats and simplification of the use of the program.

Some attention is being given to the possibility of using an idea by Titheridge for including, in the N(h) analysis of a given point, virtual height scalings beyond the point; this may make possible the scaling of fewer points without loss of accuracy. Some attention has also been given to the problem of providing values for the rate of loss of ionization by diffusion, and to the possibility of increasing the reliability and stability of the extrapolation of the true height curve to the critical frequency.

A short auxiliary computer program provides an estimate of the height of a sporadic-E layer and an associated ground-pulse error by a least-squares fit to scalings of multiple reflections. Knowledge of the ground-pulse error is sometimes helpful in correcting ionogram tracings.

A manuscript discussing these true-height analysis techniques is being edited for publication.

In a separate study, the numerical generalization of the "Abel solution" of the virtual height integral has been programmed for the CDC-3600 computer, and the results for several magnetic dip angles are being prepared for publication. The difference in the functional relationship between retardation and electron density for the two magneto-ionic components has been utilized in this systematic investigation of the amount of information to be gained from using h'_x in addition to h'_o. By separating retardation due to underlying ionization from that imposed in the observed range, certain parameters of the underlying and/or valley distribution may be determined. It has been found that the extraordinary virtual height curve contains significant additional information at high and low dip angles, but at a dip of $\sim 39^o$ the additional information is relatively limited.

2) Data Analysis and Consultation for Specific Applications:

Electron density profile calculations, and consultation for their use, have been performed for the following agencies and laboratories:

Air Force Cambridge Research Laboratories
U. S. Army Ballistic Research Laboratories
Collins Radio Company
Environmental Science Services Administration
High Altitude Observatory
IIT Research Institute
Jet Propulsion Laboratory
Lockheed Missiles and Space Company
NASA
- Goddard Space Flight Center
- Manned Spacecraft Center
- NASA Data Center (GSFC)

U. S. Naval Research Laboratories
Ohio State University
University of Callifornia at Los Angeles
University of Illinois
University of New Hampshire
University of New Mexico
Rice University
Southwest Center for Advanced Studies
Washington State University.

3) Development and Applications of an Ionospheric Climatology:

From the systematic radio soundings of the ionosphere principally along the 75°W meridian, we are continuing to obtain profile computations to represent the seasonal, diurnal, and geographical structure of the ionosphere at solar-minimum. Approximately 20 stations contribute data for this purpose. The results are being used to examine several theoretical descriptions of ionospheric production/loss/movement processes at ESSA, Pennsylvania State University, and NASA (Ames Research Center).

4) Studies of Ionospheric Physical Processes:

Continuing a program to employ the continuity equation for electrons in a study of average electron density variations, Dr. T. Shimazaki has developed a method to separate the effects of temperature variations and drift velocity on time-dependent variations of F-region electron density profiles. A paper was prepared to describe the method and the result of its application to the nighttime observations at Puerto Rico was included. The paper will be published in July 1966 issue of J. Geophy. Res. An attempt is being made to extend the method in order to make possible the analysis of daytime variations, in which the evaluation of ionization rate becomes important.